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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/883,216	06/19/2001	Jen Kuang Fang	4459-050	9853

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EXAMINER

PAREKH, NITIN

ART UNIT

PAPER NUMBER

2811

DATE MAILED: 09/10/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/883,216

Applicant(s)

FANG ET AL.

Examiner

Nitin Parekh

Art Unit

2811

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 18 June 2003.
- 2a) ☒ This action is FINAL. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-4 and 7-11 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-4 and 7-11 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 06-19-01 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____
- 4) ☐ Interview Summary (PTO-413) Paper No(s) _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

DETAILED ACTION

Claim Rejections - 35 USC § 112

1. Claim 9 is rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

Claim 9, line 2 cites: "...the removing step is conducted without completely removing an entire thickness of said titanium layer".

However, as described in the specification (see page 5, lines 15-20; Fig. 5), the removing step is performed to remove TiO or TiO₂ layers which may be formed on the titanium layer. The description does not disclose the claimed limitation of removing any thickness or the entire thickness of the titanium layer.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claims 1-4, 7, 8, 10 and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Mathew (US Pat. 4922322) in view of Li et al. (US Pat. 6312830), Kim et al. (US Pat. 6417089) and Lin (US Pat. 6426556).

Regarding claim 1, Mathew discloses a method for forming a semiconductor device having a bump electrode (19 in Fig. 4 and 5), the method comprising the steps of:

- providing an aluminum contact pad (11 in Fig. 1-5) on a substrate (10 in Fig. 1-5), the pad being exposed on a region comprising a field oxide/dielectric isolation layer (10 in Fig. 1-5) of the substrate
- forming an aluminum layer (14a in Fig. 1- 4) on the field oxide/dielectric isolation layer and the aluminum pad
- forming a nickel-vanadium layer (15 in Fig. 1- 4) on the aluminum layer
- forming a gold layer (16 in Fig. 1- 4) on the nickel-vanadium layer
- selectively forming a gold bump (19 in Fig. 1- 4; Col. 3, line 32) on the gold layer at a location corresponding to the aluminum pad, and
- etching the aluminum, nickel-vanadium and copper layers using an acidic solution/etchant (Fig. 5; Col. 3, line 47- Col. 4, line 5) using gold bump as a mask

(Fig. 1-5; Col. 3, line 5- Col. 4, line 5).

Mathew fails to teach:

- a) the contact pad being exposed through a dielectric layer and forming a titanium layer on the nickel-vanadium layer, and
- b) the gold bump being substantially unaffected during the etching step.

a) Li et al. teach providing the aluminum pad on the substrate such that the pad is exposed through a dielectric/passivation layer (45/50 and 200/220 in Fig. 1a-c and 4b respectively) to provide the desired insulation and passivation (Col. 2, line 55; Col. 4, line 2).

Li et al. further teach forming an under bump metallurgy (UBM) structure comprising a variety of configurations including a three layer structure having layers A, B and C, the layer A being adjacent to the pad and being formed on a non-refractory metal and the second and third layers (B and C) are formed of refractory metals such as titanium, titanium nitride, etc. (Col. 1, line 29-40), the layer C being in direct physical contact with the bump to improve the wetting/adhesion and diffusion barrier for the UBM structure (Col. 3, line 35). Furthermore, the material such as titanium is conventionally used as the UBM layer to improve adhesion and bonding in the UBM structure.

b) Mathew further teaches the gold bump being substantially unaffected except being slightly undercut (Fig. 5, Col. 4, line 1-5) during the etching step.

Kim et al. teach an under bump metallurgy (UBM) structure where metal/solder bumps are substantially unaffected (see bump 60 in Fig. 4D) after an exposure to conventional hydrochloric acid etch step except being slightly undercut (Col. 6, lines 10-20; Col. 7, lines 15-21). Furthermore, metal bumps made of solder or gold are conventionally used as connecting electrodes in an UBM structure to provide the desired barrier and adhesion for the chip pad/bump interconnection (see Lin: bump 35 in Fig. 15; Col. 10, line 52).

It would have been obvious to a person of ordinary skill in the art at the time invention was made to incorporate the steps of providing the aluminum pad on the substrate such that the pad is exposed through a dielectric layer and forming a titanium layer on the nickel-vanadium layer as taught by Li et al. and the gold bump being substantially unaffected during the etching step as taught by Kim et al. and Lin so that the wetting/adhesion, diffusion barrier and reliability of the UBM structure can be improved in Mathew's method.

Regarding claims 2 and 3, Mathew, Li et al., Kim et al. and Lin teach substantially the entire method as applied to the claim 1 above, except removing TiO or TiO₂ that may have been formed on the titanium layer before forming the gold bump.

Lin further teaches removing any native/surface oxide being formed on the metal layer/aluminum using a conventional cleaning step comprising a cleaning medium/acid dip/etch (Col. 9, lines 50-53) before forming a gold bump. It is well known to one of

Art Unit: 2811

ordinary skill in the art that such native/surface oxide layer is formed on a surface of conventional metals such as aluminum, titanium, copper, etc. used in UBM structure.

It would have been obvious to a person of ordinary skill in the art at the time invention was made to incorporate a step of removing TiO or TiO₂ that may have been formed on the titanium layer before forming the gold bump as taught by Lin so that the adhesion and reliability of the UBM structure can be improved in Li et al., Kim et al. and Mathew's method.

Regarding claim 4, Mathew, Li et al., Kim et al. and Lin teach substantially the entire method as applied to the claim 1 above, except the cleaning medium being HCl.

Kim et al. further teach using a step of cleaning/etching the UBM layers such as titanium using a conventional acid based cleaning step comprising a cleaning medium/solution of hydrochloric acid/HCl (Col. 4, line 65; Col. 6, line 10-20).

It would have been obvious to a person of ordinary skill in the art at the time invention was made to incorporate a step of cleaning the titanium layer using a HCl cleaning medium as taught by Kim et al. so that the wetting/adhesion and reliability of the UBM structure can be improved in Li et al., Lin and Mathew's method.

Regarding claims 7 and 8, Mathew, Li et al., Kim et al. and Lin teach substantially the entire method as applied to the claim 1 above, except etching the titanium layer utilizing the acidic solution or HCl.

Kim et al. further teach using conventional etching of UBM layers including titanium (Col. 4, line 65) using acid such as HCl (Col. 6, line 10-20).

It would have been obvious to a person of ordinary skill in the art at the time invention was made to incorporate etching aluminum, nickel-vanadium and titanium using the acidic solution such as HCl as taught by Kim et al. so that the wetting/adhesion and reliability of the UBM structure can be improved in Li et al., Lin and Mathew's method.

Regarding claim 10, Mathew, Li et al., Kim et al. and Lin teach substantially the entire method as applied to the claim 1 above, including the gold bump being in direct contact with titanium to ensure good adhesion between the gold bump and titanium.

Regarding claim 11, Mathew, Li et al., Kim et al. and Lin teach substantially the entire method as applied to the claims 1 and 10 above, except removing TiO or TiO₂ that may have been formed on the titanium layer before forming the gold bump.

Lin further teaches removing any native/surface oxide being formed on the metal layer/aluminum using a conventional cleaning step comprising a cleaning medium/acid dip/etch (Col. 9, lines 50-53) before forming a gold bump. It is well known to one of ordinary skill in the art that such native/surface oxide layer is formed on a surface of conventional metals such as aluminum, titanium, copper, etc. used in UBM structure.

It would have been obvious to a person of ordinary skill in the art at the time invention was made to incorporate a step of removing TiO or TiO₂ that may have been formed on the titanium layer before forming the gold bump as taught by Lin so that the adhesion and reliability of the UBM structure can be improved in Li et al., Kim et al. and Mathew's method.

Response to Arguments

4. Applicant's arguments with respect to claims 1-4 and 7-11 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

5. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of

Art Unit: 2811

the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

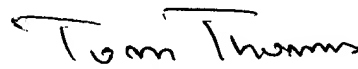
Any inquiry concerning this communication or earlier communications from the examiner should be directed to Nitin Parekh whose telephone number is 703-305-3410. The examiner can normally be reached on 09:00AM-05:30PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tom Thomas can be reached on 703-308-2772. The fax phone numbers for the organization where this application or proceeding is assigned are 703-308-7722 for regular communications and 703-308-7722 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-306-3431.

Nitin Parekh

NP
08-29-03


TOM THOMAS
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800